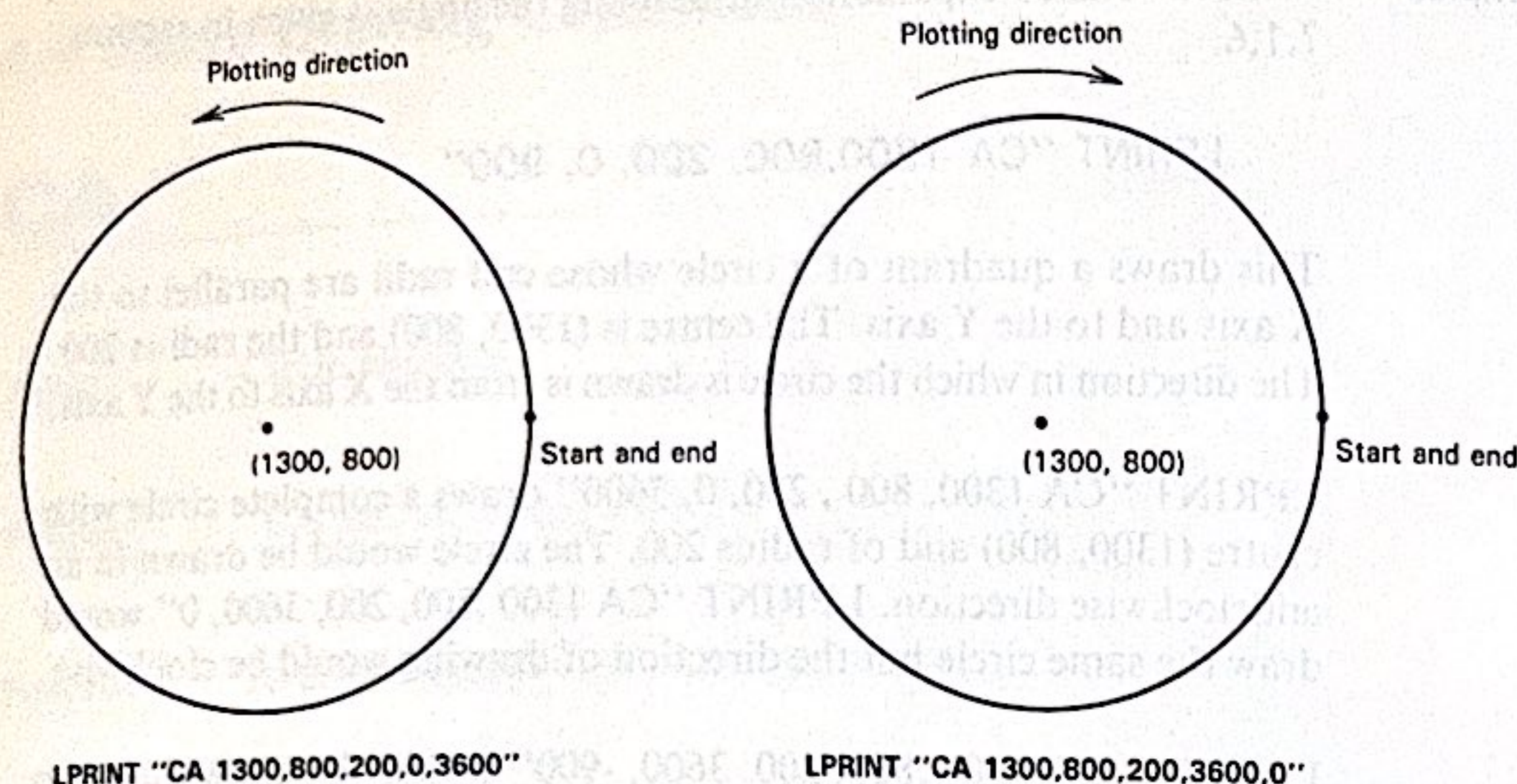




ASCII Code Sequence

Decimal

(68)_D (65)_D (XC1) (XC2)... (XCn) (44)_D
 (YC1) (YC2)... (YCn) (44)_D (R1) (R2)... (Rn)
 (44)_D (θS1) (θS2)... (θSn) (44)_D (θE1)
 (θE2)... (θEn) (13)_D

or (68)_D (65)_D (XC1) (XC2)... (XCn) (44)_D
 (YC1) (YC2)... (YCn) (44)_D (R1) (R2)... (Rn)
 (44)_D (θS1) (θS2)... (θSn) (44)_D (θE1)
 (θE2)... (θEn) (0)_D

Hexadecimal

<44>_H <41>_H <XC1> <XC2>... <XCn>
 <2C>_H <YC1> <YC2>... <YCn> <2C>_H
 <R1> <R2>... <Rn> <2C>_H <θS1>
 <θS2>... <θSn> <2C>_H <θE1>
 <θE2>... <θEn> <0D>_H

or <44>_H <41>_H <XC1> <XC2>...
 <XCn> <2C>_H <YC1> <YC2>...
 <YCn> <2C>_H <R1> <R2>... <Rn>
 <2C>_H <θS1> <θS2>... <θSn>
 <2C>_H <θE1> <θE2>... <θEn> <0>_H

Where (XC1)... (XCn) denote the ASCII codes for the characters corresponding to the decimal digits of XC, and similarly for YC, R, θS and θE.

CR

(Circle Relative)

Name

Circle relative.

Format

"CR r, θS, θE," ▽

Function

To draw a circle or arc of a circle with the drawing starting at the current pen location.

Parameter type and range:

All parameters must be included. All parameters are integer numeric strings. The radius of the circle is given by r. The starting (θS) and ending (θE) angles are given in multiples of 0.1 of a degree. The range of all these parameters (r, θS and θE) is -16383 to +16383.

If either of the absolute coordinates of any point of the circle falls outside the range -32768 to +32767 an error will be generated.

The angle of rotation is measured from the positive direction of the X axis such that if (θS - θE) is a positive angle the direction of drawing will be anticlockwise, and it is negative the direction will be clockwise.

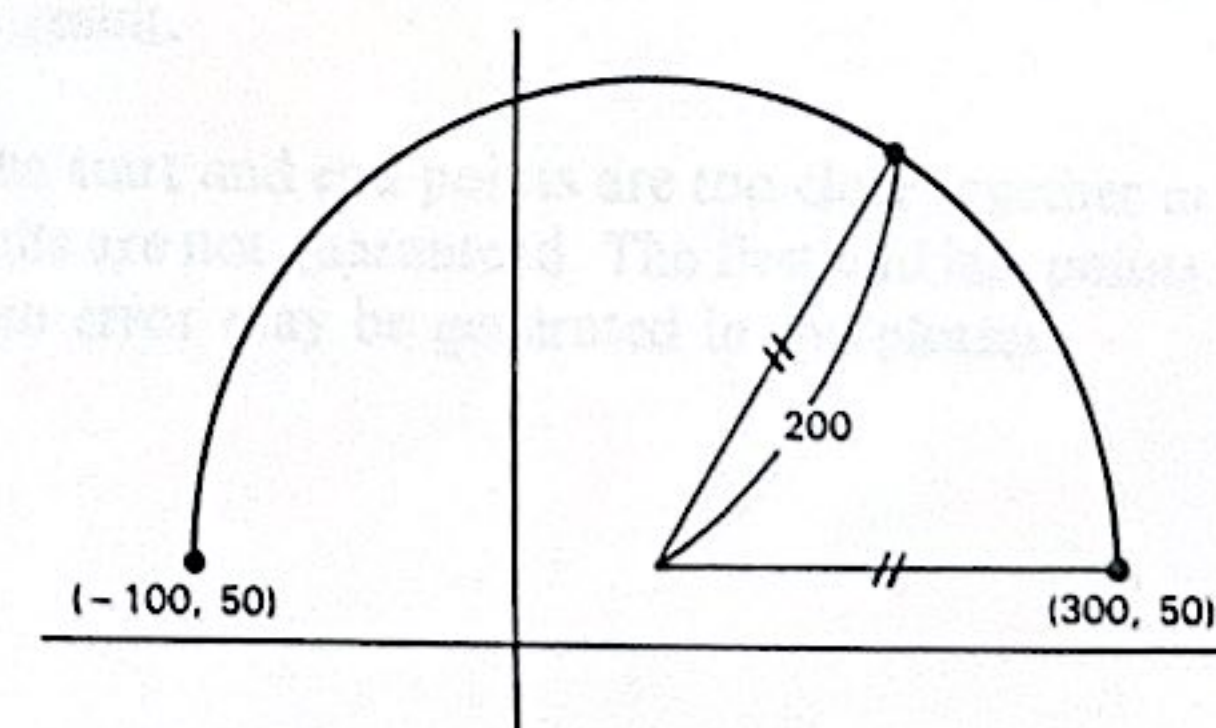
Examples

A more detailed explanation of setting the angles is given in section 7.1.6.

LPRINT "CR 200, 0,1800"

This draws a quadrant of a circle whose end radii are parallel to the X axis and to the Y axis. The circle is drawn anticlockwise with a radius of 200 units.

If the current pen location is (300, 50), LPRINT "CA 200,0,1800" would give:



LPRINT "CR 200, 0, 3600" draws a complete circle of radius 200. The circle would be drawn in an anticlockwise direction.

LPRINT "CR 200, 3600, 0" would draw the same circle but the direction of drawing would be clockwise.

LPRINT "CR 200, 3600, -900" would also draw the same circle clockwise. It would continue to draw past the starting position to a point parallel to the Y axis, drawing one quadrant twice.

ASCII Code Sequence

Decimal

(68)_D (82)_D (44)_D (R1) (R2)... (Rn) (44)_D
(θS1) (θS2)... (θSn) (44)_D (θE1) (θE2)...
(θEn) (13)_D

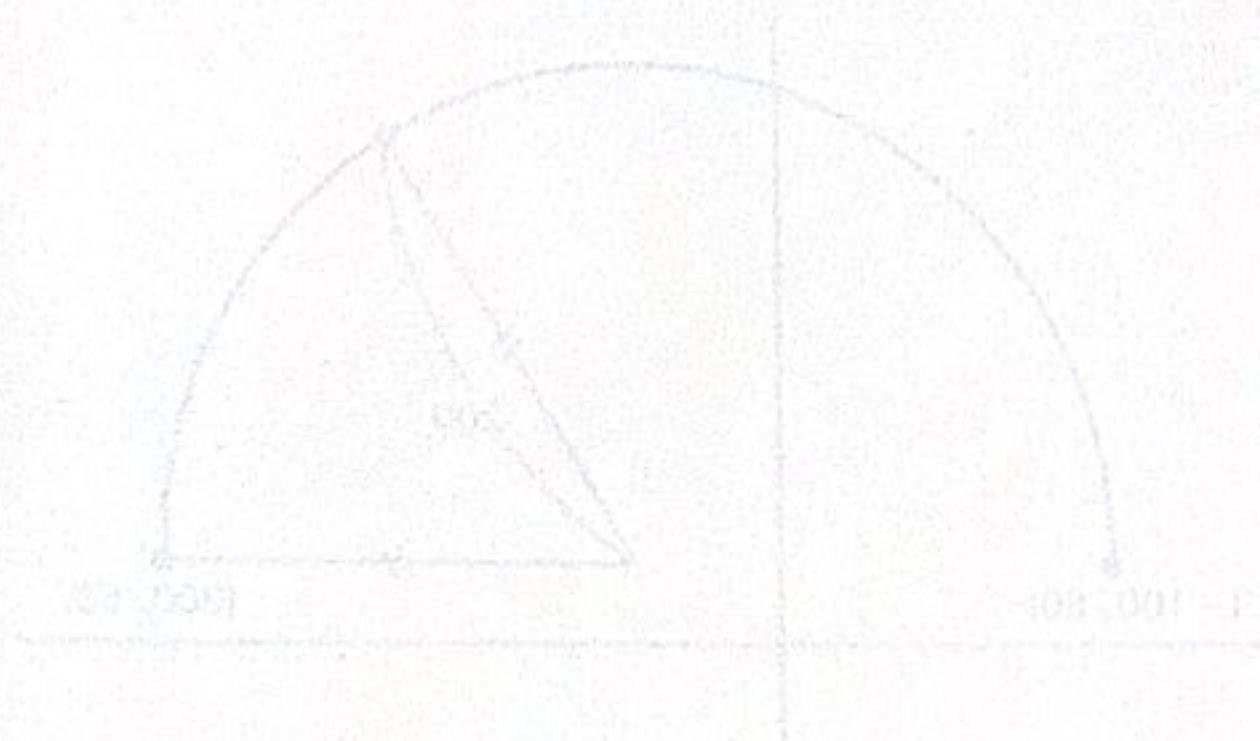
or (68)_D (82)_D (44)_D (R1) (R2)... (Rn) (44)_D
(θS1) (θS2)... (θSn) (44)_D (θE1) (θE2)...
(θEn) (0)_D

Hexadecimal

<44>_H <52>_H <2C>_H <R1> <R2>...
<Rn> <2C>_H <θS1> <θS2>...
<θSn> <2C>_H <θE1> <θE2>...
<θEn> <0D>_H

or <44>_H <52>_H <2C>_H <R1> <R2>...
<Rn> <2C>_H <θS1> <θS2>...
<θSn> <2C>_H <θE1> <θE2>...
<θEn> <00>_H

Where (R1)... (Rn) denote the ASCII codes for the characters corresponding to the decimal digits of the radius R, and similarly for θS and θE.



VA

(Curve Absolute)

Name

Curve Absolute

Format

"VA a, x1, y1, x2, y2, xn,yn" ▽

Function

To draw a smooth curve through a series of points specified by absolute coordinates.

Parameter type and range

The variable "a" is used to decide whether a closed or open curve is to be drawn. If "a" has the value 0 the curve is open. If "a" has the value "1", the curve will be plotted so that the last point is joined to the first. If any character other than a "0" or "1" is sent to the printer, an error will be generated.

The variables "x1", "y1" etc. are the values of coordinates of the points to be plotted. As with other similar commands involving strings of coordinates, the individual characters of the coordinates must be sent to the printer.

The coordinate values should be within the range - 16383 to + 16383.

There should be at least 3 points to plot the curve. If only two points are given, a straight line will be drawn.

The same point should not be specified as two successive points. Although an error will not be generated, the curve will not be smooth but will show a cusp (sharp point).

If a point is specified as the starting and ending point, this is equivalent to setting two consecutive points the same and the same problem will result.

If the start and end points are too close together or too far apart, the results are not guaranteed. The first and last points may not be joined or an error may be generated in the plotter.

ASCII Code Sequence

Decimal

(86)_D (65)_D (x1) (x2)... (xn) (44)_D (y1) (y2)...
 (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1)
 (Y2)... (Yn) (13)_D
 or (86)_D (65)_D (x1) (x2)... (xn) (44)_D (y1) (y2)...
 (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1)
 (Y2)... (Yn) (0)_D

Hexadecimal

<56>_H <41>_H <x1> <x2>... <xn>
 <xn> <2C>_H <y1> <y2>...
 <yn> <2C>_H <X1> <X2>... <Xn>
 <2C>_H <Y1> <Y2>... <Yn> <0D>_H
 or <56>_H <41>_H <x1> <x2>...
 <xn> <2C>_H <y1> <y2>... <yn>
 <2C>_H <X1> <X2>... <Xn> <2C>_H
 <Y1> <Y2>... <Yn> <0>_H

Where (x1)...(xn) and (y1) ... (yn) are the ASCII codes for the characters of the first coordinate in decimal, (X1)... (Xn) and (Y1) ... (Yn) for a subsequent one and so on.

VR

(Curve Relative)

Name

Curve Relative

Format

"VR" a, Δx1, Δy1, Δx2, Δy2, Δxn, Δyn ▽

Function

To draw a smooth curve through a series of points specified by a series of relative coordinates. The pen will draw from the current pen position. The curve will be drawn so that the coordinates (Δxn, Δyn) are plotted relative to the last point in the sequence.

Parameter type and range

The variable "a" is used to decide whether a closed or open curve is to be drawn. If "a" has the value "0" the curve is open. If "a" has the value "1", the curve will be plotted so that the last point is joined to the first. If any character other than a "0" or "1" is sent to the printer, an error will be generated.

The variables Δx1, Δy1 etc. are the relative coordinates of the points to be plotted. As with other similar commands involving strings of coordinates, the individual characters of the coordinates must be sent to the printer.

The coordinate values should be within the range - 16383 to + 16383.

Limitations such as the number of points, are exactly the same as for the "VA" command.

If the absolute value of either coordinate of the position of the pen is outside the range - 32767 and + 32767, an error will be generated.

ASCII Code Sequence

Decimal

(86)_D (82)_D (x1) (x2)... (xn) (44)_D (y1) (y2)...
 (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1)
 (Y2)... (Yn) (13)_D
 or (86)_D (82)_D (x1) (x2)... (xn) (44)_D (y1) (y2)...
 (yn) (44)_D (X1) (X2)... (Xn) (44)_D (Y1)
 (Y2)... (Yn) (0)_D

Hexadecimal

<56>_H <52>_H <x1> <x1> <x2>...
 <xn> <xn> <2C>_H <y1> <y2>...
 <yn> <2C>_H <X1> <X2>...
 <Xn> <2C>_H <Y1> <Y2>.... <Yn>
 <0D>_H

or <56>_H <52>_H <x1> <x2>... <xn>
 <2C>_H <y1> <y2>... <yn> <2C>_H
 <X1> <X2>...
 <Xn> <2C>_H <Y1> <Y2>.... <Yn>
 <0>_H

Where (x1)...(xn) and (y1) ... (yn) are the ASCII codes for the characters of the first coordinate in decimal, (X1)... (Xn) and (Y1) ... (Yn) for a subsequent one and so on.

4.5 Character Drawing Commands

LA

(Label)

Name

Label ASCII string.

Format

"LAC1C2C3C4.....Cn" ▽

Function

To draw ASCII characters whilst in the plotter mode.

Parameter type and range: The characters C1...Cn must be ASCII characters in the range 32 to 255. If a space (ASCII code 32) is inserted between the "LA" command and the first character, or a space is inserted in the character string, it will be printed as a space.

Some characters in the code table are not present. If there is no character represented, none will be printed.

If a character would be drawn outside the effective drawing area, it will be clipped in the same way as any other plotting would be.

The following commands affect the way the character is drawn:

- CS specifies the character set to be used
- SI specifies the size of the character
- EM enables emphasized (double drawn) characters
- DI specifies the direction and size of rotation
- SL specifies the angle of slant
- VO specifies the vertical offset

These parameters can be reset using the "RC" command. A table of default settings is given under the "RC" command.

It is also possible to make special marks using the "AM" and "RM" commands.

Pen position when character has been drawn.

Example

would print:

beginning at the current cursor position according to the current settings of the parameters affecting the size rotation etc.

Decimal

$$\begin{aligned} & (76)_D (65)_D (A1) (A2) \dots (A_n) (13)_D \\ \text{or } & (76)_D (65)_D (A1) (A2) \dots (A_n) (00)_D \\ & \quad \langle 4C \rangle_H \langle 41 \rangle_H \langle A1 \rangle_H \langle A2 \rangle \dots \\ & \quad \langle A_n \rangle \langle 0D \rangle_H \\ \text{or } & \langle 4C \rangle_H \langle 41 \rangle_H \langle A1 \rangle \langle A2 \rangle \dots \\ & \quad \langle A_n \rangle \langle 00 \rangle_H \end{aligned}$$

Where A1 ... An are the ASCII codes of the characters to be printed.

CS

(Character set)

Name Character set

Format "CSn" ▽

Function To select which character set is to be used when printing characters with the "LA" command.

Parameter type and range

The value of "n" determines the character set for a particular country. It has a range of "0" to "10". This enables characters which are special to the alphabet of the country to be chosen as the recognised modification to the ASCII code table. The values of n corresponding to each country and the characters produced for the codes which can change are shown in the following table:

value of n	country	(35) _D	(36) _D	(64) _D	(91) _D	(92) _D	(93) _D	(94) _D	(96) _D	(123) _D	(124) _D	(125) _D	(126) _D
0	U.S.A	#	\$	@	[	\	]	^	'	{		}	~
1	France	#	\$	à	°	ç	é	^	'	é	û	è	~
2	Germany	#	\$	ß	Ä	Ö	Ü	^	'	ä	ö	ü	ß
3	England	£	\$	@	[	\	]	^	'	{		}	~
4	Denmark	#	\$	@	Æ	Ø	Å	^	'	æ	ø	å	~
5	Sweden	#	¤	É	Å	Ö	Å	Ü	é	ä	ö	å	ü
6	Italy	#	\$	@	°	\	é	^	û	à	ò	è	ì
7	Spain	¢	\$	@	;	Ñ	¿	^	'	~	ñ	}	~
8	Japan	#	\$	@	[	¥	]	^	'	{		}	~
9	Norway	#	¤	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü
10	Denamrk II	#	\$	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü

Example

```
LPRINT "CS 3"
LPRINT "LA#$@[\\]^'{}~"
```

would print "£\$[\\]^'{}~" since character set 3 is the English character set.

ASCII Code Sequence

Decimal (67)_D (83)_D (C) (13)_D
 or (67)_D (83)_D (C) (00)_D
 Hexadecimal <43>_H <53>_H <C> <0D>_H
 or <43>_H <53>_H <C> <00>_H

Where C is the ASCII code for the character 0-9 or two characters if the tenth set is required. Thus to select country "0", the code would be (48)_D or <30>_H and so on up to (57)_D <39>_H for country "9". Where country "10" is selected, two characters need to be sent i.e. the ASCII codes for "1" and the code for "0", namely (49)_D (48)_D or <31>_H <30>_H.

SI

(Size)

Name

Character size

Format

"SI h , w" ▽

Function

To specify the height and width of the characters printed by the "LA" command and the symbols printed by the "AM" and "RM" commands.

Parameter type and range

The variables "h" and "w" are in the range 4 to 16383. As with other commands, the numerical digits of the values of "h" and "w" are sent as the ASCII codes of the digits. The value of "h" defines the height of the character and "w" the width. The height can be set by simply specifying a height parameter. If it is necessary to alter the width, both the height and width parameters must be given.

The parameters affect the character height and width as follows:

- (i) ASCII characters produced by the "LA" command:
 - character height = $h \times 0.1 \text{ mm}$
 - character width = $2/3 w \times 0.1 \text{ mm}$
 - distance between start of each character = $w \times 0.1 \text{ mm}$
- (ii) Symbols produced by "AM" or "RM" commands:
 - height = $h \times 0.1 \text{ mm}$
 - width = $w \times 0.1 \text{ mm}$
- (iii) User defined characters produced by the "LU" commands:
 - height = $h \times 0.1 \text{ mm}$
 - width = $w \times 0.1 \text{ mm}$

Example

```
LPRINT "SI 24, 64"  
LPRINT "LALook at the size."
```

would print the sentence 2.4mm high and 6.4mm wide, thus:

Look at the size.

ASCII Code Sequence

Decimal (83)_D (73)_D (H1) (H2)... (Hn) (44)_D (W1)
(W2)... (Wn) (13)_D
or (83)_D (73)_D (H1) (H2)... (Hn) (44)_D (W1)
(W2)... (Wn) (0)_D
Hexadecimal <53>_H <49>_H <H1>_H <H2>...
<Hn> <44>_D <W1> <W2>... <Wn>
<Wn> <0D>_H

Where (H1) ... (Hn) and (W1) ... (Wn) are the characters of the digits of the height and width expressed as decimal numbers.



EM

(Emphasized)

Name

Emphasized characters

Format

"EM n" ▽

Function

To produce emphasized characters. This is achieved by drawing the characters twice close together with a slight offset. There are three ways to produce the offset.

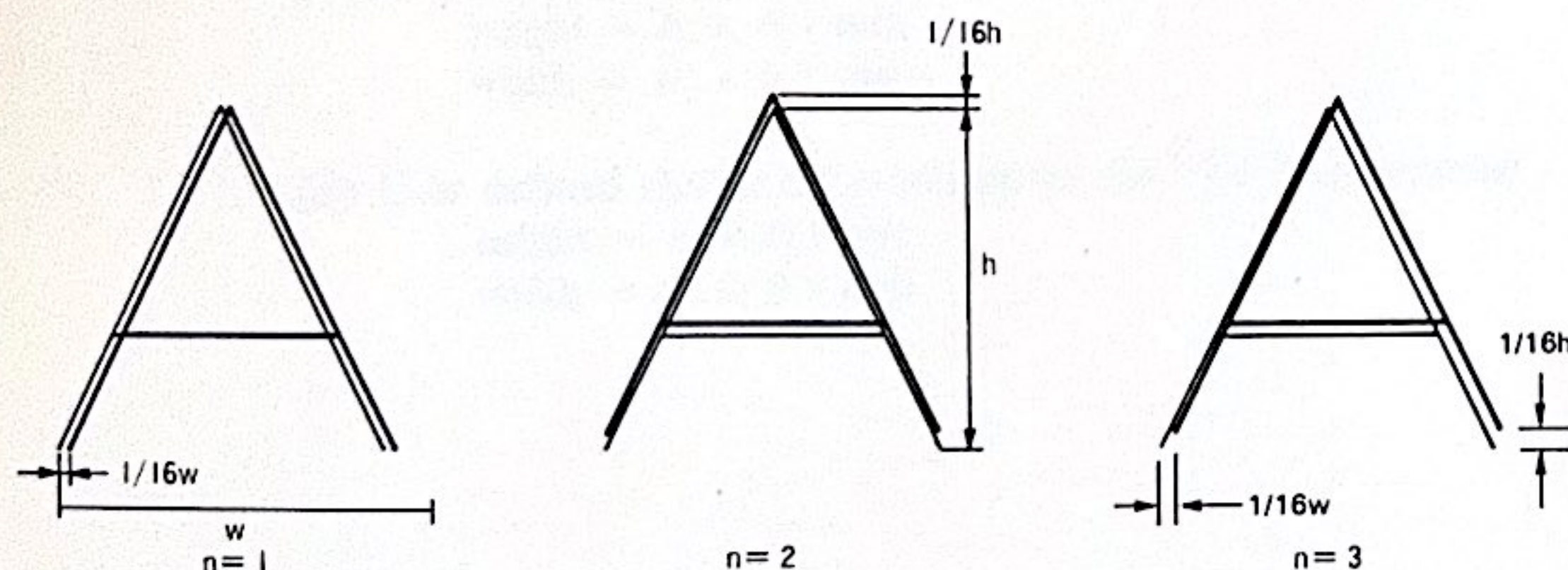
Parameter type and range

The value of "n" determines the type of offset:

- n = 0 emphasis is not used
- n = 1 the character is redrawn offset horizontally.
- n = 2 the character is redrawn offset vertically.
- n = 3 the character is redrawn offset obliquely.

The horizontal or vertical offset is $1/16$ of the horizontal or vertical width. In the oblique case, the offset character is drawn horizontally and vertically by this amount.

However, the maximum offset is 0.3 mm, so that when the value of $1/16$ of the horizontal or vertical size is greater than 0.3mm, the maximum value is used.



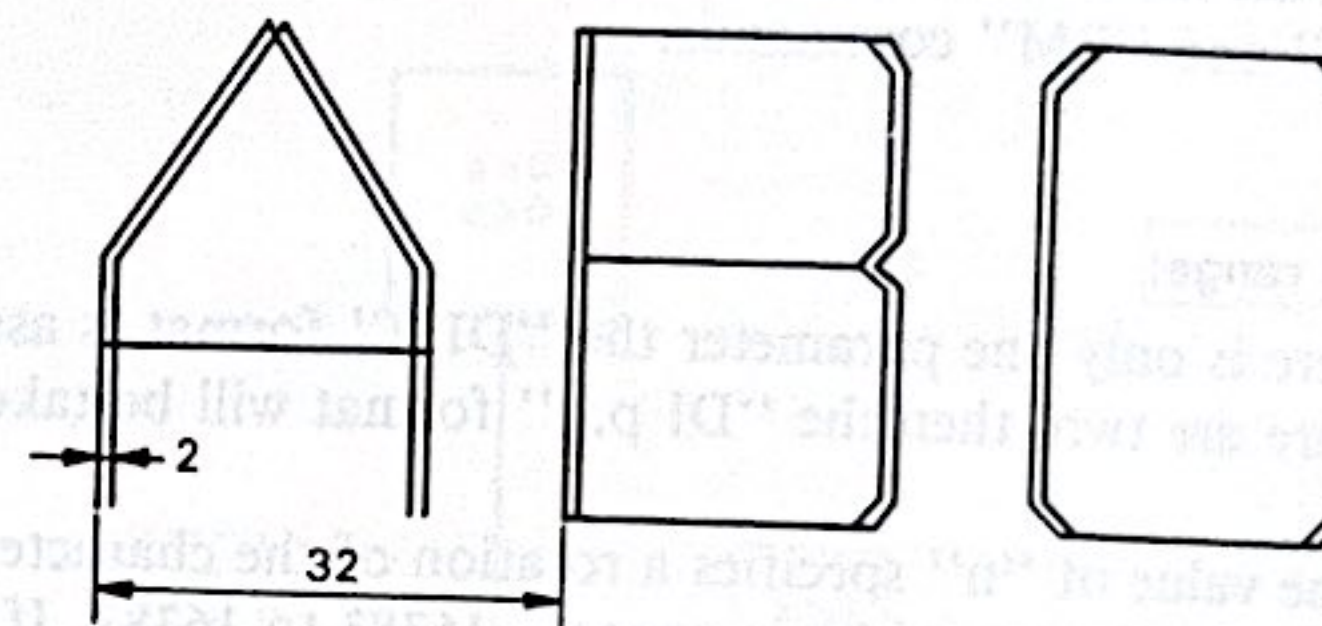
Example

```
10 LPRINT "SI 32"
20 LPRINT "EMI"
30 LPRINT "LAABC"
```

would draw as follows:

ABC

When these characters are drawn, pen movement is as shown below.



ASCII Code Sequence

Decimal	(69) _D (77) _D (N) (13) _D
or	(69) _D (77) _D (N) (00) _D
Hexadecimal	<45> _H <4D> _H <N> _H <0D> _H
or	<45> _H <4D> _H <N> _H <00> _H

Where N is the ASCII code for the character 0-3. Thus to select no emphasis, the code would be (48)_D or <30>_H and so on up to (51)_D <33>_H for oblique emphasis.

DI

(Character Direction)

Name Character Direction

Format "DI n" ▽ or
"DI p, q" ▽

Function To set the direction of rotation of characters for printing by the "LA", "AM" and "RM" commands.

Parameter type and range:

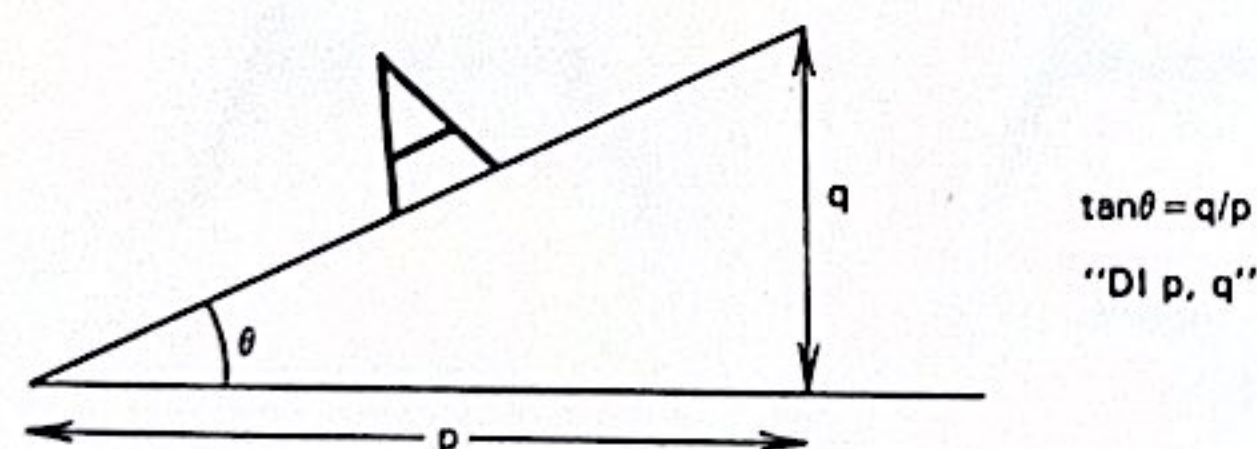
If there is only one parameter the "DI n" format is assumed.
If there are two, then the "DI p,q" format will be taken.

i) The value of "n" specifies a rotation of the character in units of 0.1 of a degree, within a range -16383 to 16383. If the value is positive rotation takes place in an anticlockwise direction. If the value is negative the rotation is clockwise. The rotation is measured from the X axis. A more detailed description of the angles is given in section 7.1.6.

ii) The second format "DI p,q" allows the angle to be specified as a tangent.

Note:

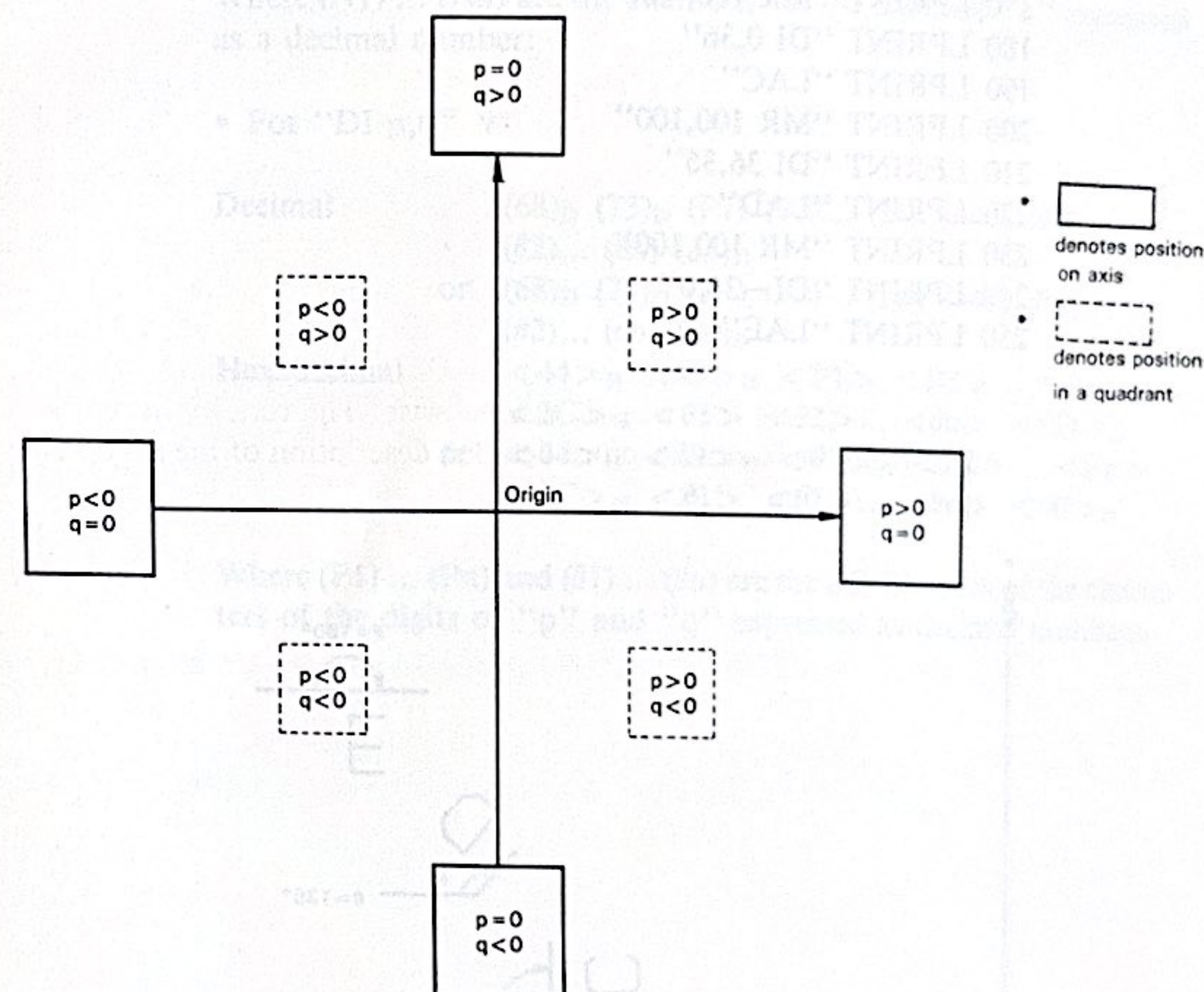
The value of p is the side adjacent to the rotation angle, and q is the opposite side, so that $TAN(\theta) = q/p$.



The values of p and q MUST NOT be zero at the same time, otherwise an overflow error will be generated.

The values of "p" and "q" can be specified as large numbers in order to obtain greater accuracy for the angle. This may add inaccuracy as a consequence of the division if the numbers cannot be dealt with by 16 bit arithmetic. The inaccuracy will only be noticed on large letters.

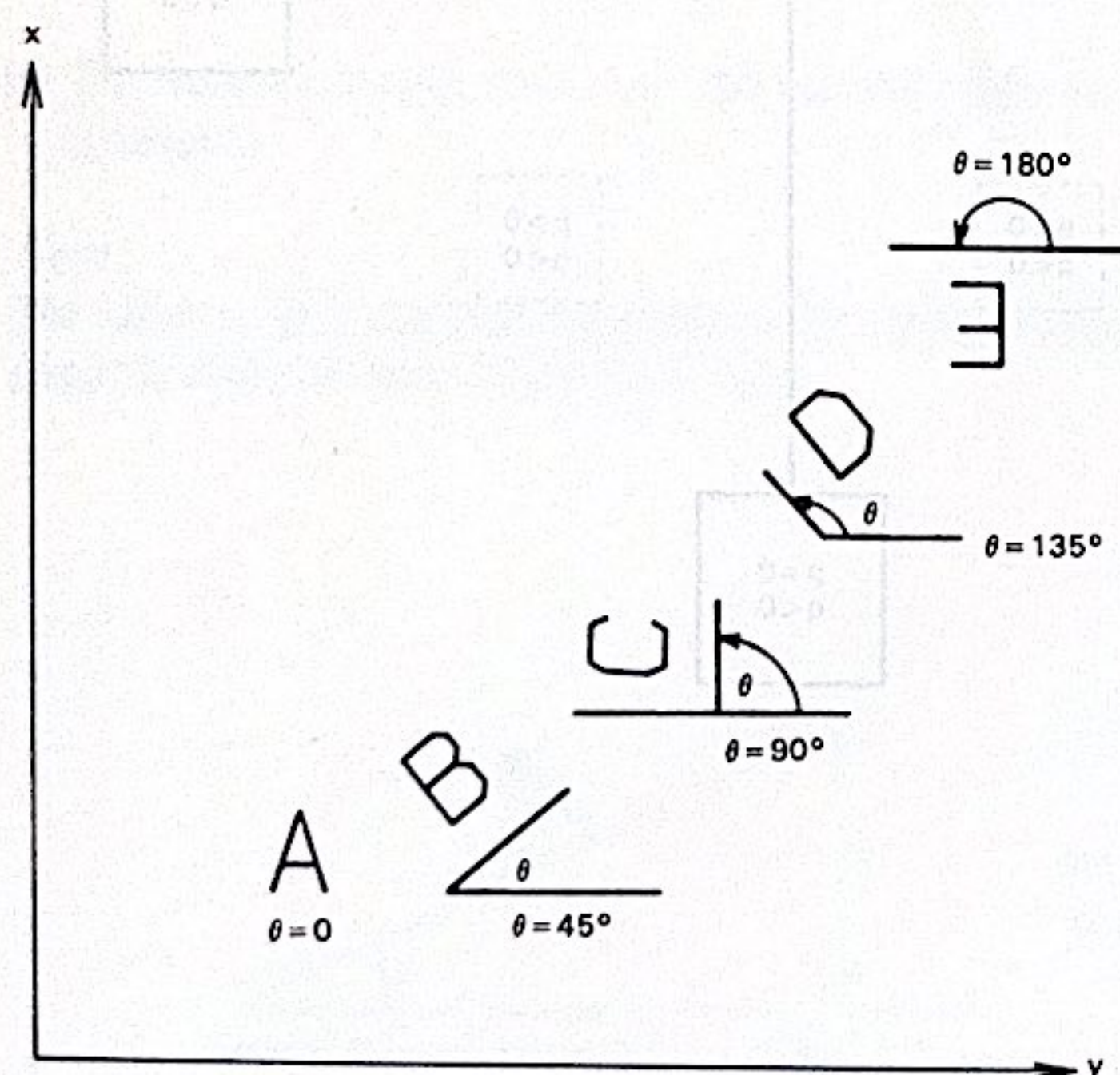
The direction of rotation will be determined as in the following diagram:



Example

The following program and plot show the result of rotating at various angles.

```
100 LPRINT "SI64,64"
110 LPRINT "MA 100, 100"
120 LPRINT "DI 36,0"
130 LPRINT "LAA"
140 LPRINT "MR 100,100"
150 LPRINT "DI 36,36"
160 LPRINT "LAB"
170 LPRINT "MR 100, 100"
180 LPRINT "DI 0,36"
190 LPRINT "LAC"
200 LPRINT "MR 100,100"
210 LPRINT "DI 36,36"
220 LPRINT "LAD"
230 LPRINT "MR 100,100"
240 LPRINT "DI -36,0"
250 LPRINT "LAE"
```



ASCII Code Sequence

- For "DI n" ▽

Decimal (68)_D (73)_D (N1) (N2)... (Nn) (13)_D
or (68)_D (73)_D (N1) (N2)... (Nn) (00)_D

Hexadecimal <44>_H <49>_H <N1> <N2>... <Nn>
<0D>_H
or <44>_H <49>_H <N1> <N2>...
<Nn> <00>_H

Where (N1) ... (Nn) are the characters of the digits of "n" expressed as a decimal number.

- For "DI p,q" ▽

Decimal (68)_D (73)_D (P1) (P2)... (Pn) (44)_D (θ1)
(θ2)... (θn) (13)_D
or (68)_D (73)_D (P1) (P2)... (Pn) (44)_D (θ1)
(θ2)... (θn) (00)_D

Hexadecimal <44>_H <49>_H <P1> <P2>... <Pn>
<2C>_H <θ1> <θ2>... <θn> <0D>_H
or <44>_H <49>_H <P1>_H <P2>... <Pn>
<2C>_H <θ1> <θ2>... <θn> <00>_H

Where (P1) ... (Pn) and (θ1) ... (θn) are the ASCII codes of the characters of the digits of "p" and "q" expressed as decimal numbers.

SL

(Slant)

Name

Slant

Format

"SL n" ▽

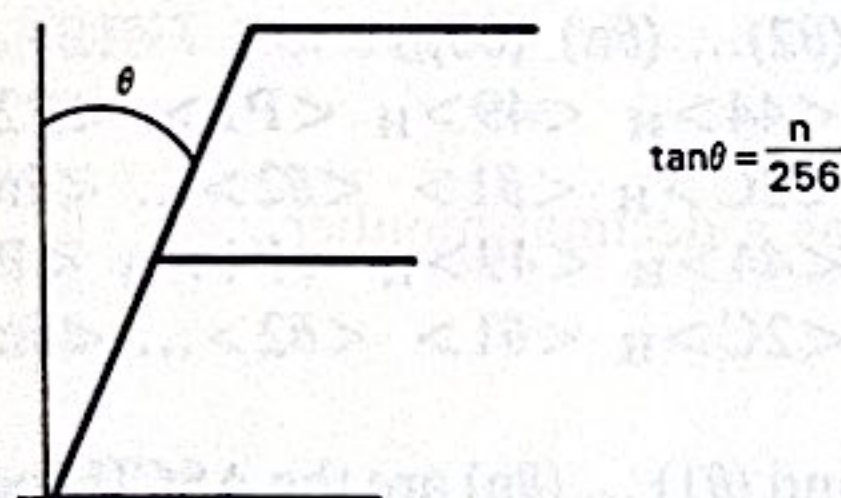
Function

To define the inclination at which a character should be printed.

Parameter type and range

The value of "n" is in the range -512 to +512. The angle of inclination is related to the value of "n" by the expression:

$$\tan \theta = n/256$$



Any lines of the character which are parallel to the base, remain parallel.

If the value of n is positive, the rotation is clockwise.

If the value of n is negative, the rotation is anticlockwise.

Example

```
5 LPRINT "SI 48,128"
10 LPRINT "SL -128"
20 LPRINT "LAE"
30 LPRINT "SL 128"
40 LPRINT "LA E"
```



n negative



n positive

ASCII Code Sequence

Decimal

(83)_D (76)_D (N1) (N2)... (Nn) (13)_D
or (83)_D (76)_D (N1) (N2)... (Nn) (0)_D

Hexadecimal

<53>_H <4C>_H <N1> <N2>... <Nn>
<0D>_H
or <53>_H <4C>_H <N1> <N2>... <Nn>
<00>_H

Where (N1) ... (Nn) are the ASCII codes of the characters of the digits of "n" expressed as a decimal number.

VO

(Vertical Offset)

Name Vertical Offset

Format "VO n" ▽

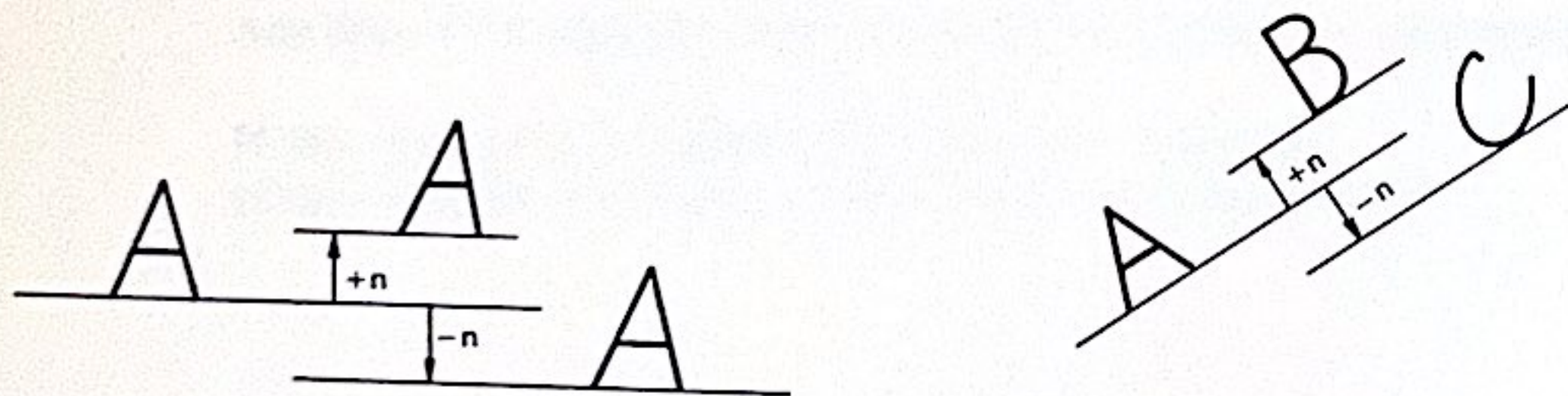
Function To specify the amount of vertical offset from the character baseline when printing a character.

Parameter type and range

The value of "n" in the range - 16383 to 16383, determines the offset in multiples of 0.1 mm.

If "n" is a positive number, the character is printed above the line. If it is negative, it will be offset below the line.

The offset is measured perpendicular to the baseline. If the baseline is slanted, this means in a clockwise direction if "n" is positive and anticlockwise if it is negative.



Example

```
LPRINT "LAXYZ"
LPRINT "VO 30"
LPRINT "LAPQR"
```

XYZ^{PQR}

ASCII Code Sequence

Decimal (86)_D (79)_D (N1) (N2)... (Nn) (13)_D
or (86)_D (79)_D (N1) (N2)... (Nn) (0)_D

Hexadecimal <56>_H <4F>_H <N1> <N2>... <Nn>
<0D>_H
or <56>_H <4F>_H <N1> <N2>... <Nn>
<00>_H

Where (N1) ... (Nn) are the ASCII codes of the characters of the digits of "n" expressed as a decimal number.

RC

(Reset Characters)

Name

Reset character functions.

Format

"RC" ▽

Function

To reset the functions relating to the way characters are printed to the default state without resetting the drawing functions.

The characters printed by the commands "LA", "AM", and "RM" are set to the following default values. These values are the default values on power up, or by giving the "DF" or "IN" commands in plotter mode 0.

COMMAND	NAME	DEFAULT	EFFECT
CS	Character Set	n = 0	Sets code table defined by DIP switch setting.
SI	Character Size	n = 24	Sets characters to 2.4 by 2.4 mm
DI	Character Direction	n = 0	Rotation angle is 0°.
SL	Character Slant	n = 0	Characters are vertical.
VO	Vertical Offset	n = 0	No offset
EM	Character Emphasis	n = 0	No emphasis

ASCII Code Sequence

Decimal (82)_D (67)_D (13)_D
or (82)_D (67)_D (0)_D

Hexadecimal <52>_H <43>_H <0D>_H
or <52>_H <43>_H <0>_H

LU*

(Label User)

Name

Label with user defined ASCII string character

Format

"LUC1C2C3C4.....Cn" ▽

Function

To draw ASCII characters whilst in the plotter mode using characters defined by the user into the optional RAM.

NOTE:

The optional RAM must be installed and DIP SW-3 set to OFF for this command to be valid.

Parameter type and range

The characters C1...Cn must be ASCII characters in the range 32 to 255. The characters printed are those defined into the particular ASCII code equivalent to the character C1...Cn. If a space(ASCII code 32) is inserted between the "LU" command and the first character, or a space is inserted in the character string, it will be printed as the character defined into ASCII code 32.

If no character is defined into a particular ASCII code a space will be printed.

The characters are treated the same as characters printed by the "LA" command.

If a character would be drawn outside the effective drawing area, it will be clipped in the same way as any other plotting would be.

The following commands affect the way the character is drawn:

CS specifies the character set to be used
SI specifies the size of the character
EM enables emphasized (double drawn) characters
DI specifies the direction and size of rotation
SL specifies the angle of slant
VO specifies the vertical offset

These parameters can be reset using the "RC" command. A table of default settings is given under the "RC" command.

The "LA" command explanation describes other points related to the way the characters are drawn.

Example see the "UC" command.

ASCII Code Sequence

Decimal (76)_D (85)_D (A1) (A2)... (An) (13)_D
 or (76)_D (85)_D (A1) (A2)... (An) (00)_D
 Hexadecimal <4C>_H <55>_H <A1> <A2>... <An>
 <0D>_H
 or <4C>_H <55>_H <A1> <A2>...
 <An> <00>_H

Where A1 ... An are the ASCII codes of the defined characters to be printed.

UC*

(User Define)

Name User defined characters.

Format "UC c ,U, x1, y1, ,U x2, y2,, U, xk, yk" ▽

Function To define a set of characters in the printer which can be used instead of the conventional ASCII set.

NOTE:

The optional RAM must be installed and DIP SW-3 set to OFF for this command to be valid.

Parameter type and range

The parameters denote the character to be defined and how to draw the character on a 14 by 14 grid.

c is a number corresponding to the ASCII code of the character to be redefined. It must be in the range 32 to 255 since the control codes cannot be redefined.

U is the character "u" or "U". It is only inserted along with its following delimiter if it is required to move the pen around the grid without drawing a line. It only applies to the pair of coordinates immediately following it.

The values of "x" and "y" denote the coordinates of the grid to draw to. This is best explained by the example below.

The user defined RAM is 8K bytes. If a large number of characters are defined which have numerous parameters, no further characters can be defined once the RAM has been used up. Moreover, if the RAM overflows while a character is being defined, then the definition for that character becomes invalid. A parameter range error will be generated at this state.

A parameter range error will also be generated if more than 255 parameters are specified.

Characters defined by this command can be printed in plotter mode 0 using the "LU" command, and in printer mode using the <ESC> "% command to set the user defined character set.

To erase a particular character use the command:

"UC c"

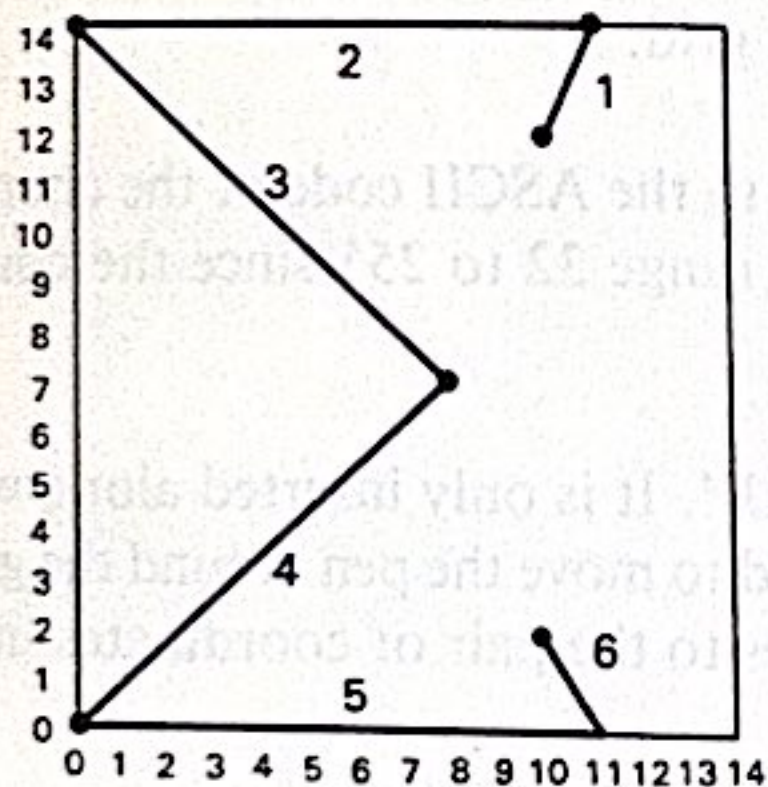
Where "c" is the ASCII code of the character to be erased.

To erase all characters, use the "IN" command.

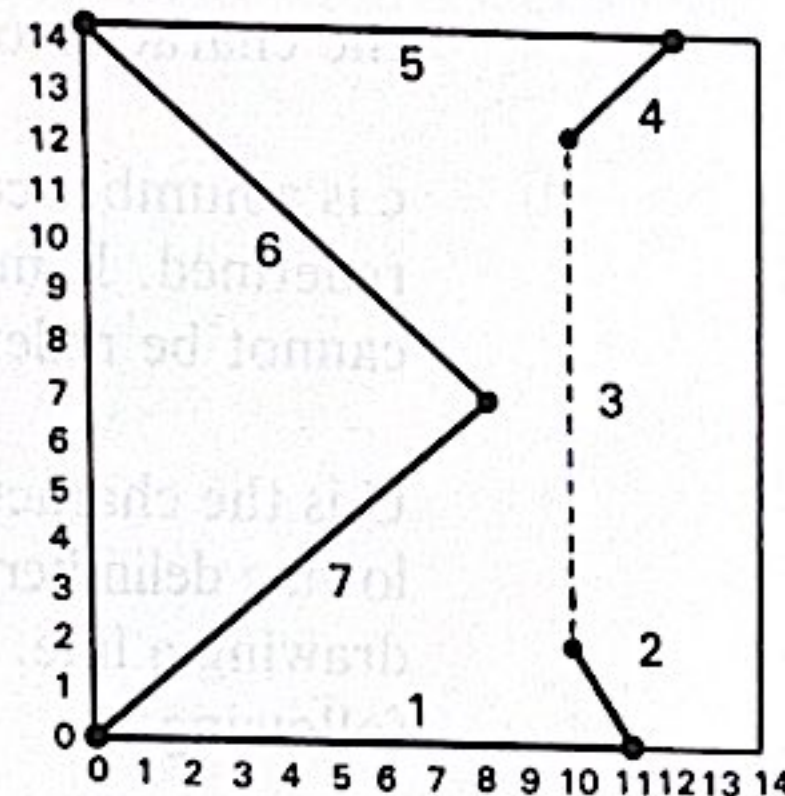
Example

The character to be defined is the Greek letter Sigma. There are many ways to define a letter such as this, depending on the order of drawing the lines. Two ways will be described which illustrate different problems which might arise.

The character will be defined into the ASCII codes (65)_D and (66)_D. The position on the grid is as shown in the diagrams. The left diagram shows the order of drawing the lines of the character into ASCII code (65)_D and the right into ASCII code (66)_D.



Character defined into ASCII code (65)_D.
Showing order of drawing lines.



Character defined into ASCII code (66)_D.
Showing order of drawing lines.

Lines are drawn from the points of the grid as shown. The points are defined as absolute locations on the grid. The pen starts at position (0,0) and moves to the first point before drawing. Thus the parameter "U" is assumed for the first point.

The coordinates of the ends of the lines for the first definition of the character in the order drawn are:

(10,12) (11,14) (0,14) (8,7) (0,0) (11,0) and (10,2)

The pen does not need to be raised at any point. When the lines have been drawn, the pen is raised automatically and moved to the point (14,0) ready to draw the next character.

The command to draw the character is thus:

"UC 65, 10,12 11,14, 8,7, 0,0, 11,0, 10,2"

For the second definition the pen moves from point (0,0) to the point (11,0) in drawing the first line. The pen must be placed at the point (0,0) by giving this as the first command. The third line begins after the pen has been raised and moved vertically. Thus a "U" command has to be inserted in the command sequence to denote the raising of the pen for that particular move. The coordinates of the ends of the lines with the position of raising are:

(0,0) (11,0) (10,2) raised here (10,12) (11,14) (0,14) (8,7) (0,0)

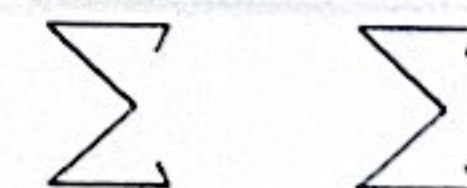
giving the command:

"UC 66, 0,0, 11,0, 10,2, U, 10,12, 11,14, 0,14, 8,7, 0,0"

These characters can then be printed in plotter mode using the commands "LUA" and "LUB" respectively since the letter "A" is ASCII code (65)_D and "B" is ASCII code (66)_D.

Having set the printer to the alternate character set with the sequence <ESC> "% " CHR\$(0); CHR\$(0), simply printing the letters "A" and "B" will give the download characters.

```
10 LPRINT "UC 65,10,12,11,14,0,14,8,7,0,0,11,0,10,2"
20 LPRINT "UC 66,0,0,11,0,10,2,U,10,12,11,14,0,14,8,7,0,0"
25 LPRINT "SI 100,100"
30 LPRINT "LUA "
40 LPRINT "LUB"
```



AR

(Arrow)

Name

Arrow

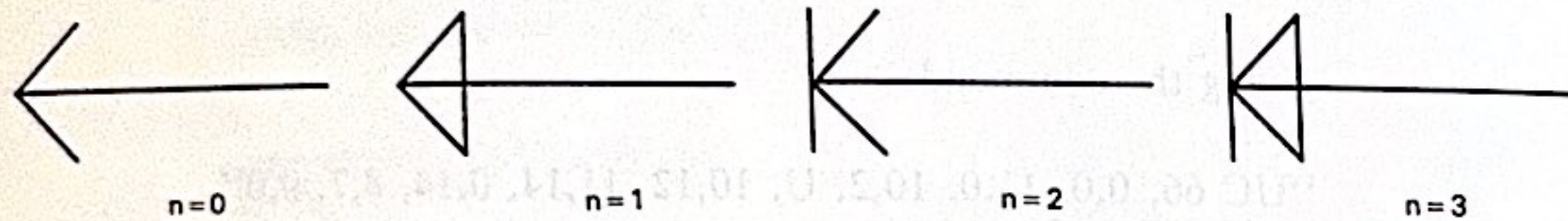
Format

"AR n, h, θ , Δx , Δy , d" ▽

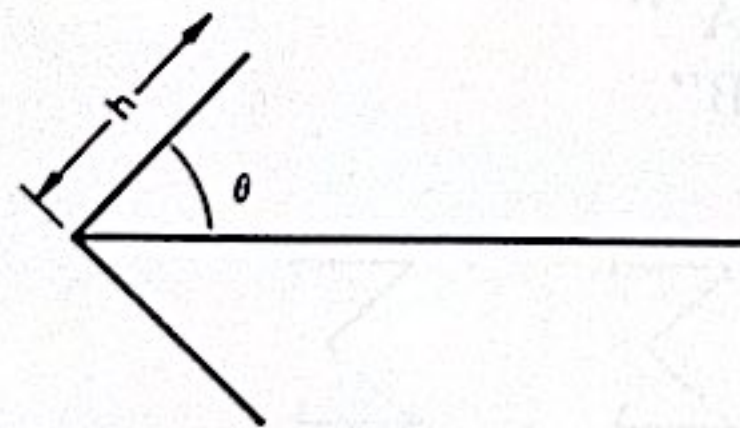
Parameter type and range

The dimensions and position of the arrow are given by the parameters as follows:

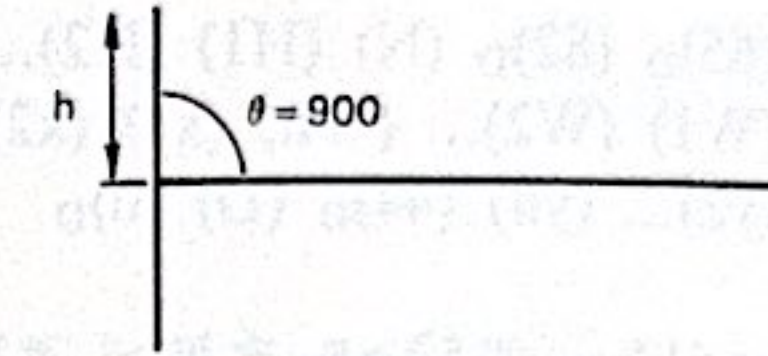
n has a range 0 to 3 and determines the type of arrow drawn as follows:



Parameters "h" and " θ " determine the size of the head of the arrow. The parameter "h" in the range 0 to 16383 determines the length of the head in units of 0.1 mm. The parameter " θ " determines the angle between this line and the shaft of the arrow. It has a range of 0 to 1800, corresponding to the lines of the head being in line with the shaft at the two extremes. When the value is "0" the lines lie on top of the shaft and when it is "1800" they extend the shaft along its length by a length given by "h".



If a value of "900" is specified for " θ " (as in the following diagram), a perpendicular pair of lines will be generated, which is useful for diagrams such as electronic circuits and architectural plans.



If a values of " Δx " and " Δy " determine the relative coordinate to which the arrow is drawn from the current pen location. The values of these relative coordinates must be within the range -16383 to 16383 inclusive. If the absolute coordinate of any part of the arrow is outside the range -32768 to +32767 an error will be generated.

The value of "d" specifies the position of the head of the arrow:

- d = 0 draws the head at the destination point
- d = 1 draws the head at the starting point (i.e. the current pen location)
- d = 2 draws the head at both ends of the arrow.

All parameters must be specified unless they are zero.

Examples

LPRINT "MA 300,300"
LPRINT "AR 1,20,50, 0,300,0"

would draw an arrow from pen position (300,300) to position (300,600) with an arrow head which is triangular and which is drawn at the position (300,600), the destination point.



ASCII Code Sequence

Decimal

(65)_D (82)_D (N) (H1) (H2)... (Hn) (44)_D
(W1) (W2)... (Wn) (x1) (x2)... (xn) (44)_D (y1)
(y2)... (yn) (44)_D (D) (13)_D

or (65)_D (82)_D (N) (H1) (H2)... (Hn) (44)_D
(W1) (W2)... (Wn) (x1) (x2)... (xn) (44)_D (y1)
(y2)... (yn) (44)_D (D) (0)_D

Hexadecimal

<41>_D <52>_D <N> <H1> <H2>...
<Hn> <2C>_H <W1> <W2>... <Wn>
<x1> <x2>... <xn> <2C>_D <y1>
<y2>... <yn> <2C>_H <D> <0D>_H

or <41>_D <52>_D <N> <H1> <H2>...
<Hn> <2C>_H <W1> <W2>... <Wn>
<x1> <x2>... <xn> <2C>_D <y1>
<y2>... <yn> <2C>_H <D> <00>_H

Where (N) is the ASCII code for the value of "n" i.e. (48)_D, (49)_D, (50)_D or (51)_D, depending on whether "n" is "0", "1", "2" or "3". The codes (H1) ... (Hn) and (W1) ... (Wn) are the characters of the digits of the height and width expressed as decimal numbers. Similarly (x1) ... (xn) and (y1) ... (yn) denote the digits of "x" and "y" respectively. Finally (D) is the ASCII code for the value of "d" i.e. (48)_D, (49)_D, (50)_D or (51)_D, depending on whether "d" is "0", "1" or "2".

4.6 Graph Drawing Commands

AX

(Axis)

Name

Axis

Format

"AX p, q, r, s, b, e, d, m" ▽

Function

To draw a line at the current pen position parallel to either the X or Y axis and graduate it.

Parameter type and range

p specifies the direction of the axis and the type of parameter for q, r and e as in table below.

p = 0 or 2 draws parallel to Y axis

p = 1 or 3 draws parallel to X axis

q specifies either the unit length of the divisions or the overall length of the line in the range - 16383 to + 16383, but MUST NOT be 0.

r specifies either the number of repetitions or the number of divisions, and is in the range 1 to 255.

s specifies whether the scale mark is written at the origin

s = 0 mark and scale value written at origin

s = 1 no mark or scale value written at origin

The remaining parameters enable the axis to be labelled, and may be omitted if not required. They must ALL be omitted along with the leading comma. When they are omitted, the axis will be unlabelled.

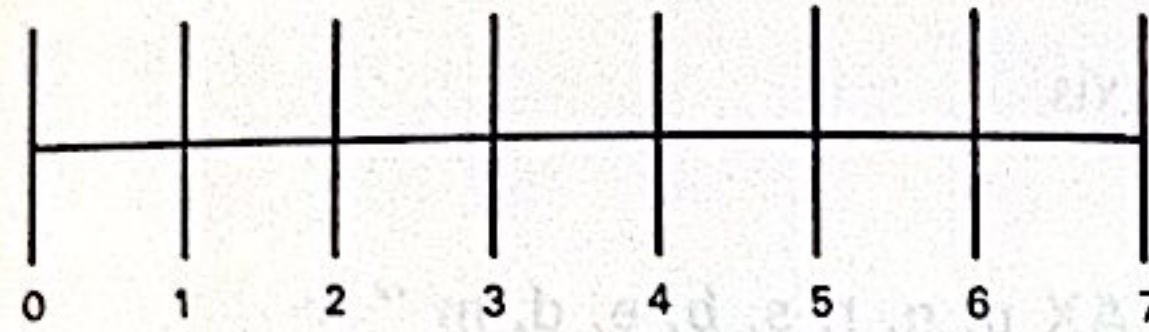
b specifies the starting value of scale numbers in the range - 16383 to + 16383.

e specifies the end value or increment of the scale numbers. The range is also - 16383 to + 16383

d specifies the distance between the line and scale numbers in the range - 16383 to + 16383.

m specifies whether the scale numbers are written parallel or perpendicular to the axis.

m = 0 parallel
m = 1 perpendicular



The following table shows the parameter type of q,r and e when p takes different values.

p	AXIS	q	r	e
0	Y	Unit length	number of repetitions	Increment
1	X			
2	Y	Overall length	Number of Divisions	End value
3	X			

When p = 0 or 1, the axis line is drawn and divided into a number of equal parts according to the value of "r". The ticks are then made and finally the labelling is carried out according to the incremental value given by "e".

When p = 2 or 3 the value of q/r i.e. the overall length divided by the number of divisions is used to find the unit length. If it is not an integer, the remainder is discarded. This results in a slightly shorter line. For example, if the command is given as follows:

LPRINT "AX 2, 1000, 13, 0"

This should plot an axis which is 100 mm long, with 13 tick marks. However since $1000/13 = 76.9231$, there is a considerable remainder which will be discarded. The unit length will therefore be 76 units of 0.1 mm which total $76 \times 13 \times 0.1 = 98.8$ mm. Thus the line is 1.2 mm shorter than the true figures.

When p = 2 or 3 the value of "e" is used to specify the end value for the numbers on the axis. If the difference between the starting and ending values leaves a remainder when divided by the number of divisions specified by "r", the remainder will be ignored. For example, specifying the start as "0" and the final value as "105" with "6" divisions would give an increment of 17 since $105/6 = 17.5$. The scale would thus be marked in units of 17, but the end value would be 102, since this is 6×17 .

To draw the axis in the negative direction, make "q" negative.

All characters are drawn according to the settings of the "SI" (size) "SL" (slant), "VO" (vertical offset) and "EM" (emphasized) commands. The "DI" (directional rotation) is not taken into account, but is set to be either parallel or perpendicular to the axis by the "m" parameter of the Axis command.

The scale numbers are centred on the tick marks. However, if the character has an offset this will move them from this position. Also if the character size is such that the height of the characters is greater than the unit length, the characters will overlap.

The position of the scale from the axis is set by the "d" parameter.

Both the ticks and the axis line will be drawn as a solid line regardless of the setting of the "LT" (line type) command.

ASCII Code Sequence

Decimal

(65)_D (88)_D (P) (44)_D (Q) (44)_D (R1) (R2)...
(Rn) (44)_D (S) (44)_D (B1) (B2)... (Bn) (44)_D
(E1) (E2)... (En) (44)_D (D1) (D2)... (D3)
(44)_D (M) (13)_D

or (65)_D (88)_D (P) (44)_D (Q) (44)_D (R1) (R2)...
(Rn) (44)_D (S) (44)_D (B1) (B2)... (Bn) (44)_D
(E1) (E2)... (En) (44)_D (D1) (D2)... (D3)
(44)_D (M) (00)_D

Hexadecimal

```
<41>_H <58>_H <P> <2C>_H <Q>
<2C>_H <R1> <R2>... <Rn> <2C>_H
<S> <2C>_H <B1> <B2>... <Bn>
<2C>_H <E1> <E2>... <En> <2C>_H
<D1> <D2>...
<D3> <2C>_H <M> <0D>_H
```

or

```
<41>_H <58>_H <P> <2C>_H <Q>
<2C>_H <R1> <R2>... <Rn> <2C>_H
<S> <2C>_H <B1> <B2>... <Bn>
<2C>_H <E1> <E2>... <En> <2C>_H
<D1> <D2>... <D3> <2C>_H <M>
<00>_H
```

Where (P) is the ASCII code for the parameter "p", (Q) for "q", (S) for "s", (M) for "m", (R1) ... (Rn) for the characters of the digits of the value of "r" expressed in decimal and similarly with (Bn), (En) and (Dn).

TL

(Tick Length)

Name

Tick length

Format

"TL p,n" ▽

Function

To specify the height of the positive and negative parts of the tick to be marked on the axis when using the "AX" command.

Parameter type and range

The variables "p" and "n" are in the range 0 to 16383, where each unit corresponds to 0.1mm.

As with other commands, the numerical digits of the values of "p" and "n" are sent as the ASCII codes of the digits. The value of "p" defines the height of the tick in the positive direction and "n" in the negative direction.

The default value of both lengths is 10 i.e. a length of 1 mm.

The line is always drawn solidly, regardless of the setting of "LT".

ASCII Code Sequence

Decimal (84)_D (76)_D (P1) (P2)... (Pn) (44)_D (N1) (N2)... (Nn) (13)_D
or (84)_D (76)_D (P1) (P2)... (Pn) (44)_D (N1) (N2)... (Nn) (0)_D

Hexadecimal <54>_H <4C>_H <P1> <P2>... <Pn> <2C>_H <N1> <N2>... <Nn> <0D>_H
or <54>_H <4C>_H <P1> <P2>... <Pn> <2C>_H <N1> <N2>... <Nn> <00>_H

Where (P1) ... (Pn) and (N1) ... (Nn) are the ASCII codes for the characters of the digits of the positive and negative mark heights expressed as decimal numbers.

GR

(Grid)

Name Grid

Format "GR p,q,r,s" ▽

Function To draw grid lines parallel to the X or Y axis.

Parameter type and range

The values of the various parameters specify the unit length of the grid rectangles and the number of lines to be drawn in each direction.

p specifies the unit length in the X direction. An error will be generated if the value of "p" is "0", or if it is outside the range - 16383 to + 16383

q specifies the number of lines to be drawn perpendicular to the X axis in the range 0 to 255 inclusive.

r specifies the unit length in the Y direction. An error will be generated if the value of "r" is "0", or if it is outside the range - 16383 to + 16383

s specifies the number of lines to be drawn perpendicular to the Y axis in the range 0 to 255 inclusive.

The type of line to be drawn is specified by the "LT" command.

The line is drawn from the current pen position, and the direction in which the grid lies relative to the coordinates of the current pen position is decided by the sign of "p" and "r".

When a grid is drawn, the first line is drawn parallel to the X axis, and then alternatively left and right depending on the direction of the first line. When the lines in the X direction have been drawn, the pen returns to the original pen position before drawing the lines in the Y direction in the same way.

This means the pen position at the end of the grid drawing procedure will be at an unknown (although predictable) position, the pen should be reset to a known position using the "MA" command.

ASCII Code Sequence

Decimal

(71)_D (82)_D (P1) (P2)... (Pn) (44)_D (Q1)
(Q2)... (Qn) (44)_D (R1) (R2)... (Rn) (44)_D
(S1) (S2)... (Sn) (13)_D
or
(71)_D (82)_D (P1) (P2)... (Pn) (44)_D (Q1)
(Q2)... (Qn) (44)_D (R1) (R2)... (Rn) (44)_D
(S1) (S2)... (Sn) (00)_D

Hexadecimal

<47>_H <52>_H <P1> <P2>... <Pn>
<2C>_H <Q1> <Q2>... <Qn> <2C>_H
<R1> <R2>... <Rn> <2C>_H <S1>
<S2>... <0D>_H

or

<47>_H <52>_H <P1> <P2>... <Pn>
<2C>_H <Q1> <Q2>... <Qn> <2C>_H
<R1> <R2>...
<Rn> <2C>_H <S1> <S2>...
<Sn> <00>_H

Where (Pn) (Qn) etc are the ASCII codes for the decimal digits of the parameters.

HB

(Hatch Bar)

Name

Hatch Bar

Format

"HB n,sx,sy,d,t" ▽

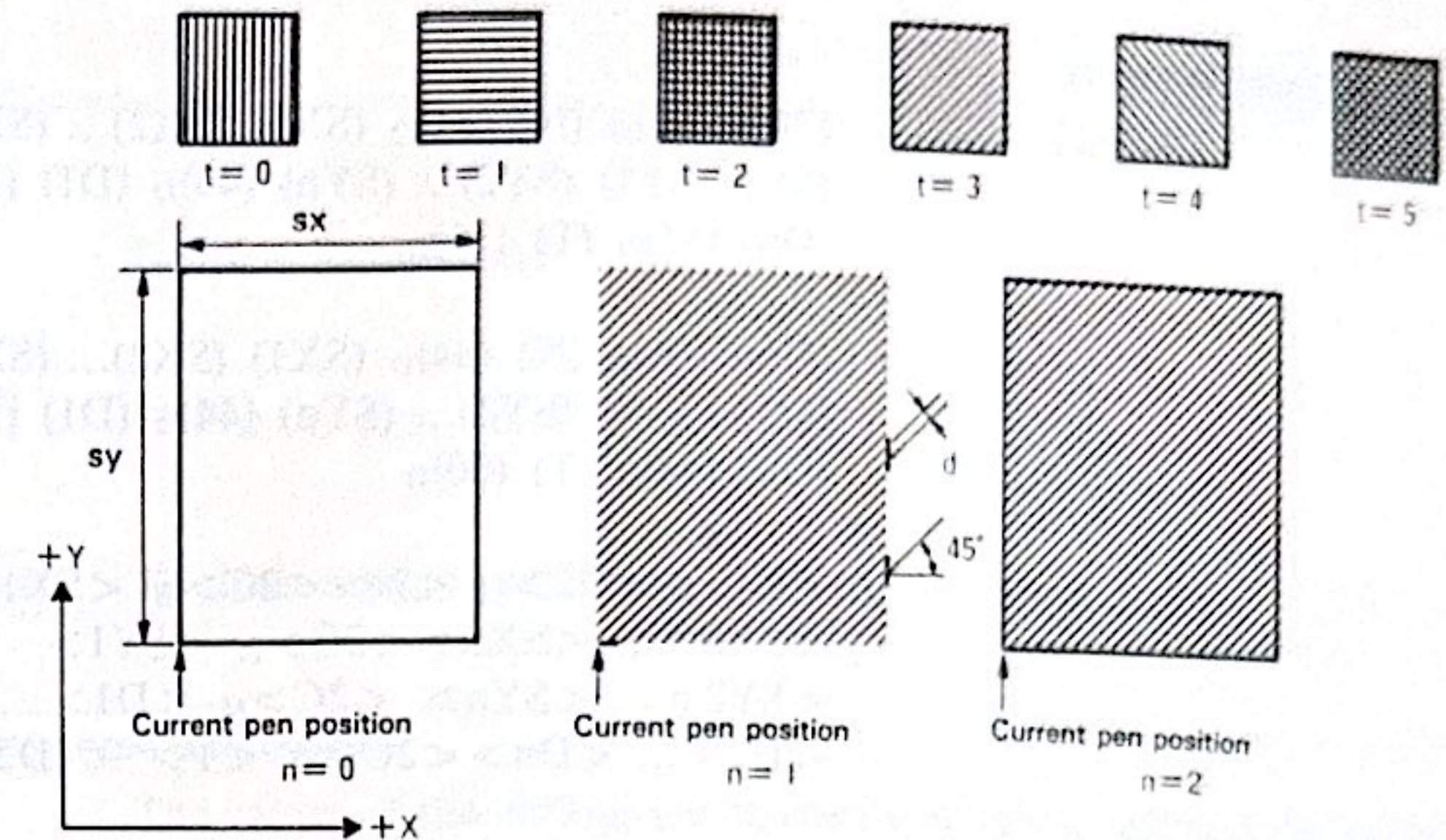
Function

To draw a rectangle parallel to the X and Y axes and hatch it.

Parameter type and range

The values of the various parameters specify the sides of the rectangle, whether it should be hatched and whether the border should be drawn.

- n specifies the type of bar to be drawn.
 n = 0 draws the rectangle only.
 n = 1 draws the hatched part only.
 n = 2 draws the rectangle and hatches it.
- sx specifies the length of the side to be drawn parallel to the X axis, in the range -16383 to 16383 in units of 0.1mm.
- sy specifies the unit length in the Y direction. An error will be generated if it is outside the range -16383 to +16383.
- d specifies the pitch of the hatching in multiples of 0.1mm. By specifying a value of "1" at normal magnification, the bar will be filled in.
- t specifies the type of hatching pattern and has the range 0 to 5. The various possibilities are shown below.



The type of line to be drawn is specified by the "LT" command. This will specify both the border and the hatching. If a different border and hatching is required, draw the border first using a value of "0" for "n", then reset the line type and redraw using a value of "1" for "n".

The line is drawn from the current pen position, and the direction in which the bar lies relative to the coordinates of the current pen position is decided by the sign of "sx" and "sy".

The pen position at the end of the drawing procedure will be at an unknown but predictable position. Therefore the pen should be reset to a known position using the "MA" command, after using the command. The only exception to this is if the bar is not hatched, in which case the pen returns to its starting position.

ASCII Code Sequence Decimal

(72)_D (66)_D (N) (44)_D (SX1) (SX2)... (SX_n)
(44)_D (SY1) (SY2)... (SY_n) (44)_D (D1) (D2)...
(D_n) (44)_D (T) (13)_D

or (72)_D (66)_D (N) (44)_D (SX1) (SX2)... (SX_n)
(44)_D (SY1) (SY2)... (SY_n) (44)_D (D1) (D2)...
(D_n) (44)_D (T) (00)_D

Hexadecimal

<48>_H <42>_H <N> <2C>_H <SX1>
<SX2>... <SX_n> <2C>_H <SY1>
<SY2>... <SY_n> <2C>_H <D1>
<D2>... <D_n> <2C>_H <T> <0D>_H

or <48>_H <42>_H <N> <2C>_H <SX1>
<SX2>... <SX_n> <2C>_H <SY1>
<SY2>... <SY_n> <2C>_H <D1>
<D2>... <D_n> <2C>_D <T> <00>_H

Where (N) (D) (T) (SX_n) (SY_n) etc are the ASCII codes for the decimal digits of the parameters.

HP

(Hatch Pie)

Name

Hatch a Pie segment

Format

"HP n, x, y, r, θS, θE d, t, rc" ▽

Function

To draw a pie segment and hatch it.

Parameter type and range

The values of the various parameters specify the radius of the circle, the starting and ending positions for the pie, whether it should be hatched and whether the border should be drawn, and if there should be an inner circle cut out of the pie. Further details of the circle are given in section 4.4.

All parameters except "rc", the radius of the inner circle, must be included.

- n specifies the type of pie to be drawn.
 - n = 0 draws the edge only.
 - n = 1 draws the hatched part only.
 - n = 2 draws the border and carries out the hatching.

x and y specify the centre of the circle in the range -16383 to 16383 in units of 0.1mm.

r specifies the radius of the outer circle in the range 0 to 16383.
θS is the angle of the starting radius of the pie measured from the X axis.

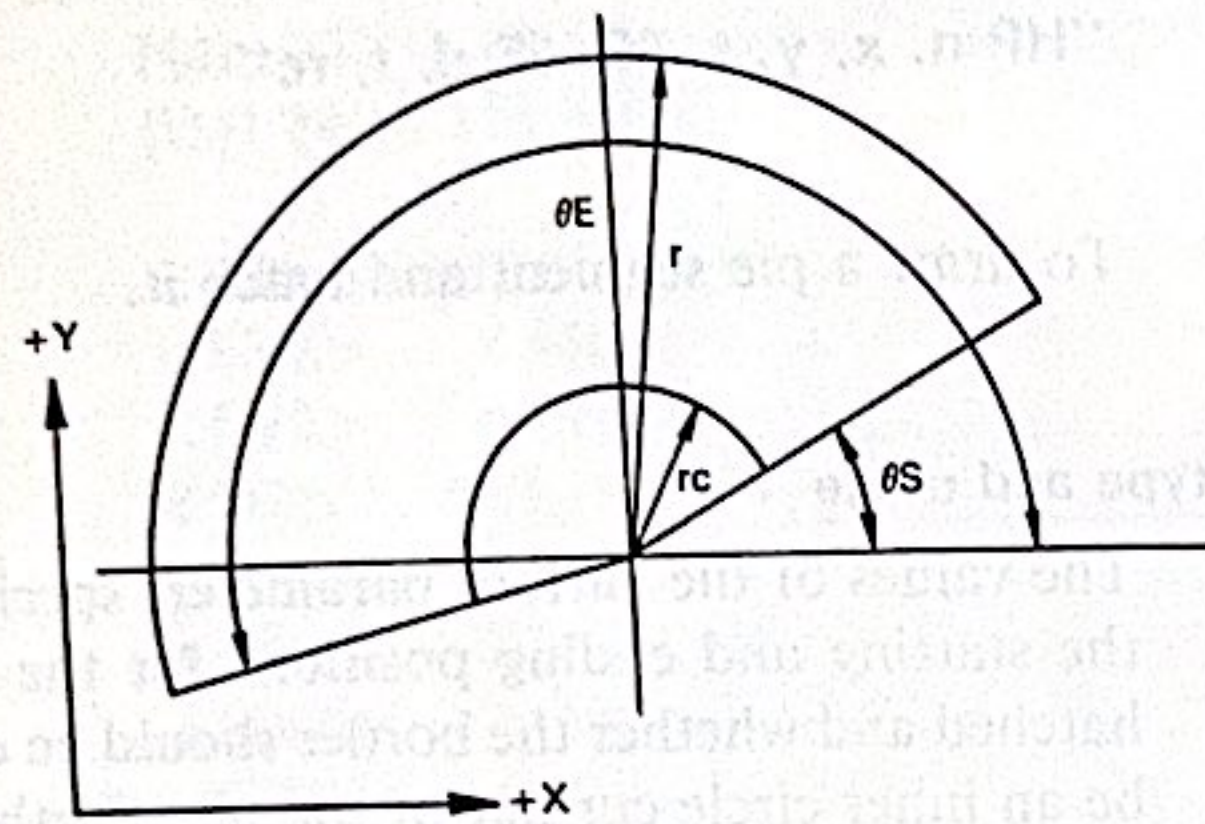
θE is the angle of the ending radius. Both angles are specified in the range -3600 to +3600. If θE is greater than θS the rotation is anticlockwise.

d specifies the pitch of the hatching in multiples of 0.1mm. By specifying a value of "1" at normal magnification, the bar will be filled in.

t specifies the type of hatching pattern and has the range 0 to 5. The various possibilities are shown under the "HB" command.

rc

specifies the inner circle radius. The value of rc can be omitted, in which case the preceding comma must be omitted also. In this case, the pie is drawn from the centre of the circle. If rc is specified with a value less than r, rc will be taken as the radius of the outer circle, and r as that of the inner.



The type of line to be drawn is specified by the "LT" command. This will specify both the border and the hatching. If a different border and hatching is required, draw the border first using a value of "0" for "n", then reset the line type and redraw using a value of "1" for "n".

The pie is drawn from an absolute pen position, specified as the centre of the circle.

The pen position at the end of the drawing procedure will be at an unknown position. Therefore the pen should be reset to a known position using the "MA" command, after using the command.

ASCII Code Sequence

Decimal

```
(72)D (80)D (N) (44)D (X1) (X2)... (Xn)
(44)D (Y1) (Y2)... (Yn) (44)D (R1) (R2)...
(Rn) (44)D (θS1) (θS2)... (θSn) (44)D (θE1)
(θE2)... (θEn) (D1) (D2)... (Dn) (44)D (T)
(44)D (RC1) (RC2)... (RCn) (13)D
```

or

```
(72)D (80)D (N) (44)D (X1) (X2)... (Xn)
(44)D (Y1) (Y2)... (Yn) (44)D (R1) (R2)...
(Rn) (44)D (θS1) (θS2)... (θSn) (44)D (θE1)
(θE2)... (θEn) (D1) (D2)... (Dn) (44)D (T)
(44)D (RC1) (RC2)... (RCn) (00)D
```

Hexadecimal

```
<48>H <50>H <N> <2C>H <X1>
<X2>... <Xn> <2C>H <Y1> <Y2>...
<Yn> <2C>H <R1> <R1> <Rn>
<2C>H <θS1> <θS2>...
<θE1> <θE2>... <θEn> <2C>H <D1>
<D2>... <Dn> <2C>H <T> <2C>H
<RC1> <RC2>... <RCn> <0D>H
```

or

```
<48>H <50>H <N> <2C>H <X1>
<X2>... <Xn> <2C>H <Y1> <Y2>...
<Yn> <2C>H <R1> <R2>... <Rn>
<2C>H <θS1> <θS2>... <θE1>
<θE2>... <θEn> <2C>H <D1>
<D2>... <Dn> <2C>H <T> <2C>H
<RC1> <RC2>... <RCn> <00>H
```

Where (N) (D) (T) (Xn) (Yn) etc are the ASCII codes for the decimal digits of the parameters.

AM

(Absolute Mark)

Name

Absolute Line and Mark

Format

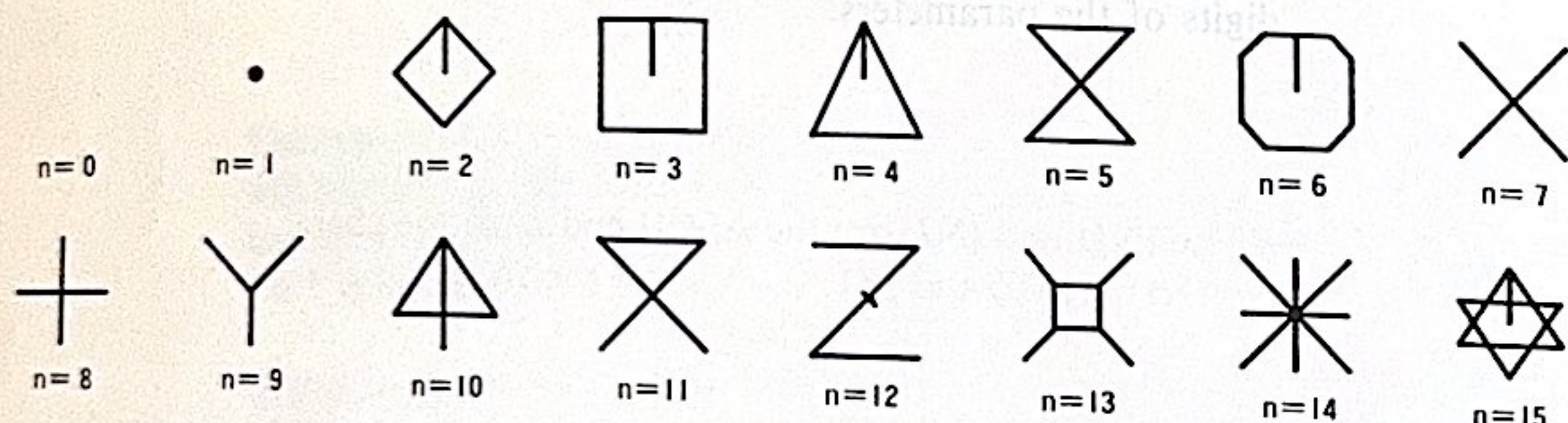
"AM n, x1, y1, x2, y2, xn, yn" ▽

Function

To draw a series of lines between a number of absolute points plotting a specified mark at each point.

Parameter type and range

The variables "n" specifies the mark according to the following table in the range 0 to 15.



The size and rotation of the mark can be specified using the "SI" and "DI" commands respectively.

The marks are placed at the coordinates specified by (x1,y1) (x2,y2) etc. If no coordinates are given, the mark is placed at the current pen location.

A line is drawn between the coordinates specified, according to the line type specified by the "LT" command.

The plotting of each mark starts and ends at the same position so that some marks have lines which draw from the centre of the mark to the border.

ASCII Code Sequence

Decimal

(65)_D (77)_D (N1) (N2) (44)_D (X1) (X2)...
(Xn) (44)_D (Y1) (Y2)... (Yn) (44)_D (x1) (x2)...
(x3) (44)_D (y1) (y2)... (yn) (13)_D

or (65)_D (77)_D (N1) (N2) (44)_D (X1) (X2)...
(Xn) (44)_D (Y1) (Y2)... (Yn) (44)_D (x1) (x2)...
(x3) (44)_D (y1) (y2)... (yn) (00)_D

Hexadecimal

<41>_H <4D>_H <N1> <N2> <2C>_H
<X1> <X2>... <Xn> <2C>_D
<Y1> <Y2>... <Yn> <2C>_H <x1>
<x2>... <x3> <2C>_H <y1> <y2>...
<yn> <0D>_H

or <41>_H <4D>_H <N> <2C>_H <2C>_H
<X1> <X2>... <Xn> <2C>_D <Y1>
<Y2>... <Yn> <2C>_H <x1> <x2>...
<x3> <2C>_H <y1> <y2>...
<yn> <00>_H

Where (N1) and (N2) are the ASCII codes for the characters of "n" and (X1)... (Xn) and (Y1) ... (Yn) are the codes for the characters of the coordinates of the first point specified as a decimal number, and (xn), (yn) of the next point and so on.